Study on Dam Health Diagnosis with Vibration Monitoring of Dam Body

(Study period: FY2016 to FY2018)
KONDO Masafumi, Head, SATO Hiroyuki, Senior Researcher, KOBORI Toshihide (Dr. Eng.), Researcher
Large-scale Hydraulic Structure Division, River Department

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1. Introduction

For the dams in the country, safety management is conducted carefully including various types of measurement (water leakage, dam body displacement, etc.) and safety patrol. However, the number of dams that need maintenance is increasing including those in service over several tens of years after construction. Accordingly, it is becoming important to develop and disseminate a technique that enables efficient monitoring of the soundness of structures in order to prolong the life of dams.

Then, we focused on the indicators showing the vibration characteristics of the dam body, including ground motion waveform data observed on the dam and the number of proper vibration identified from the measurement of microtremors, and aim to establish a technique to monitor changes in the structural soundness of dams due to the passing of the years or a large-scale earthquake in reference to changes in the foregoing indicators.

2. Analysis of the vibration characteristics of dams and usability and issues

For the dams under the control of the MLIT, seismographs (Fig. 1) are installed in principle on the base and top of each dam in order to use the monitoring data for judgment of whether extraordinary inspection is necessary in case of an earthquake and improvement of the seismic design technique. In addition, microtremor measurement, which can grasp the vibration characteristics of the ground or structure at any time and any location, has become relatively easier to conduct due mainly to the dissemination of portable measuring equipment with a built-in acceleration sensor of high sensitivity, etc. (Fig. 1)

The vibration characteristics of the dam body can be obtained by analyzing the response characteristics (transfer function) in the frequency domain based on such earthquake ground motion observation record and microtremor measurement data obtained simultaneously at the top (crown) and base of the dam body. This study aims to detect changes in the soundness of the dam body by checking the fall in the number of proper vibration or changes in the damping mechanism, which results from the reduction of rigidity as a structure due to joint misalignment, crack, etc. However, since the number of proper vibration is also affected by discharge vibration in addition to reservoir level and outside air temperature, such factors specific to the dam should be considered in analysis and evaluation. In addition, there are few cases where focus is placed on changes in the vibration characteristics in analyzing the effect of a large-scale earthquake. For this reason, analysis is advanced, also trying the device of analytical methods, such as visualization (Fig. 2) etc. of the variation per hour of the transfer function obtained from the earthquake ground motion observation data.

3. Future perspective

We are going to continue to develop reasonable analytical methods for vibration characteristics and diagnosis indicators aiming to establish / disseminate this technique in dam soundness diagnosis and monitoring.

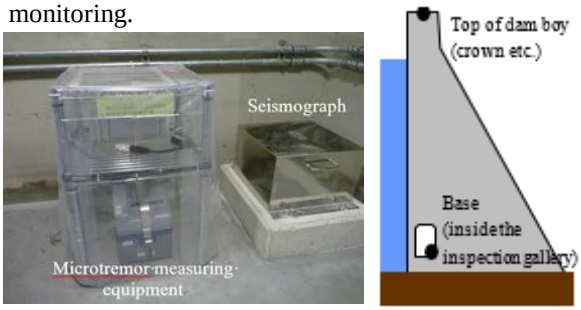

Figure 1: Examples for seismograph / microtremor measuring equipment and measurement spots

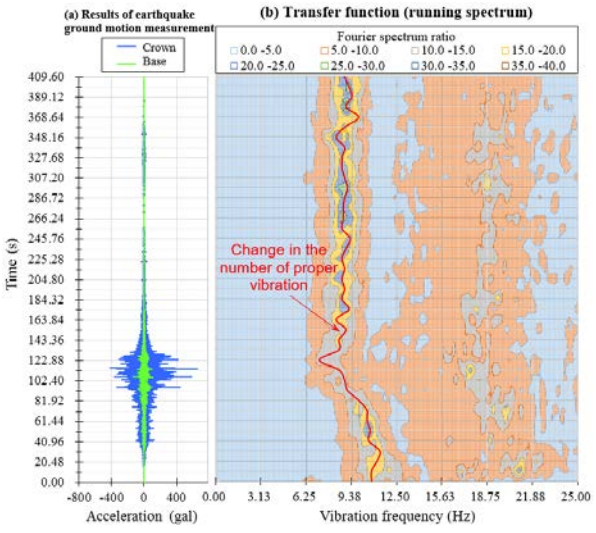

Figure 2: Running spectrum of the transfer function of a gravity dam body (Example for analysis of the number of proper vibration in case of a large-scale earthquake)